Disruption Costing Methodology ValSim –

visualization and simulation of airline operations

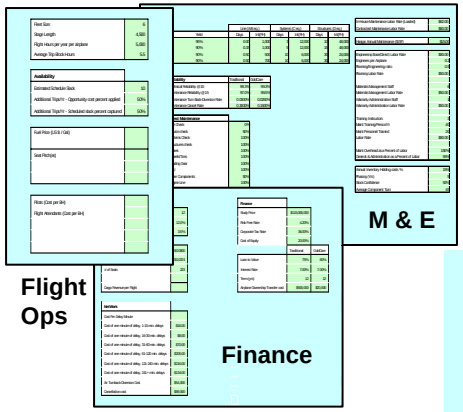
- Delay Methodology
- Costs of Delays

AGIFORS Ops Control, Denver 2007

Kaaren Cramer and Michael Irrgang

Airline Delay Analysis Methodology

Gather Ground Rules



Flight Following Data

(One year of data is requested)

Flight Type	Equipment Type	Tail #	Flt #	Sched Origin	Actual Origin	Sched Dest	Actual Dest	UTC Sch.Dep	UTC Sch.Arr	Est. Air Time	UTC Out	UTC Off	UTC On	UTC In	Cycles
SCHD	787	XY-ABC	45	IAH	IAH	OUA	OUA	12/25/2004 23:25	12/26/2004 2:20	2:15	12/26/2004 0:15	12/26/2004 0:50	12/26/2004 3:15	12/26/2004 3:20	1

Delay Codes

Boeing Maintenance Data

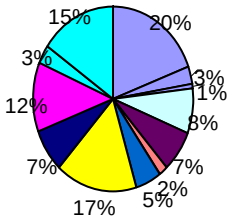
$$\text{Direct\_PAX\_cost} = \begin{cases} 0 & \text{if } DL \le \gamma_1 \\ \alpha_1 - \beta_1(DL) & \text{if } DL \ge \gamma_1 \end{cases}$$

$$\text{Direct\_operating\_cost} = \begin{cases} 0 & \text{if } DL \le \gamma_1 \\ \alpha_1 + \beta_2(DL) & \text{if } DL \ge \gamma_1 \end{cases}$$

$$\text{Loss\_aircraft\_available} = \begin{cases} \alpha_3(\text{DL})^2 & \text{if } DL \le \gamma_3 \\ \alpha_3(\gamma_3)^2 & \text{if } DL \ge \gamma_3 \end{cases}$$

$$\text{Cost\_customer\_disloyalty} = \begin{cases} \alpha_4(DL)^2 - \beta_4(\text{DL}) & \text{if } DL \le \gamma_3 \\ \alpha_4(\gamma_3)^2 & \text{if } DL \ge \gamma_3 \end{cases}$$

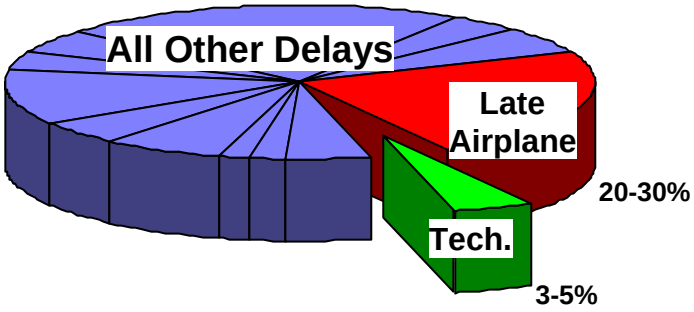
Cleanup & Analyze Data



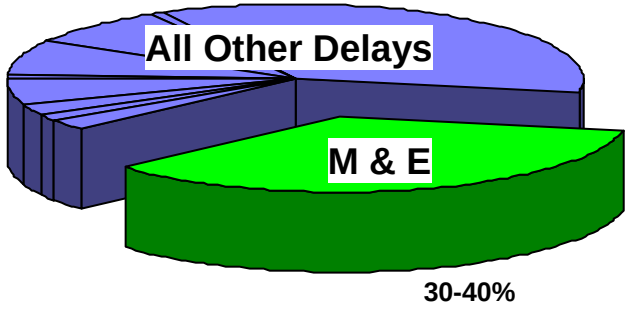
Delay Methodology Thinking Transition

Delay Count: Events → Minutes

Traditional View:
Initial Delay Event Counts

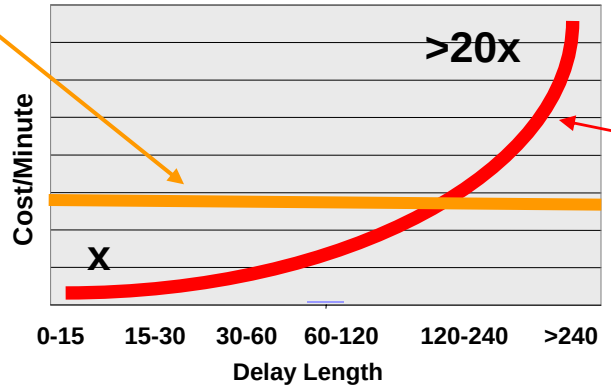


New View:
Total Minutes Caused by Events

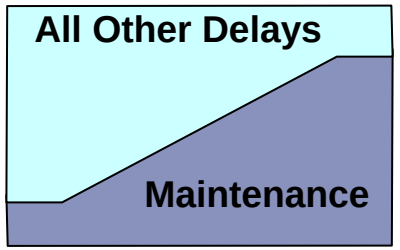


Delay Cost: Average → Accelerating

Traditional View:
Per Minute Cost
Same for all Delays



New View:
Per Minute Cost
Increases with
Delay Length

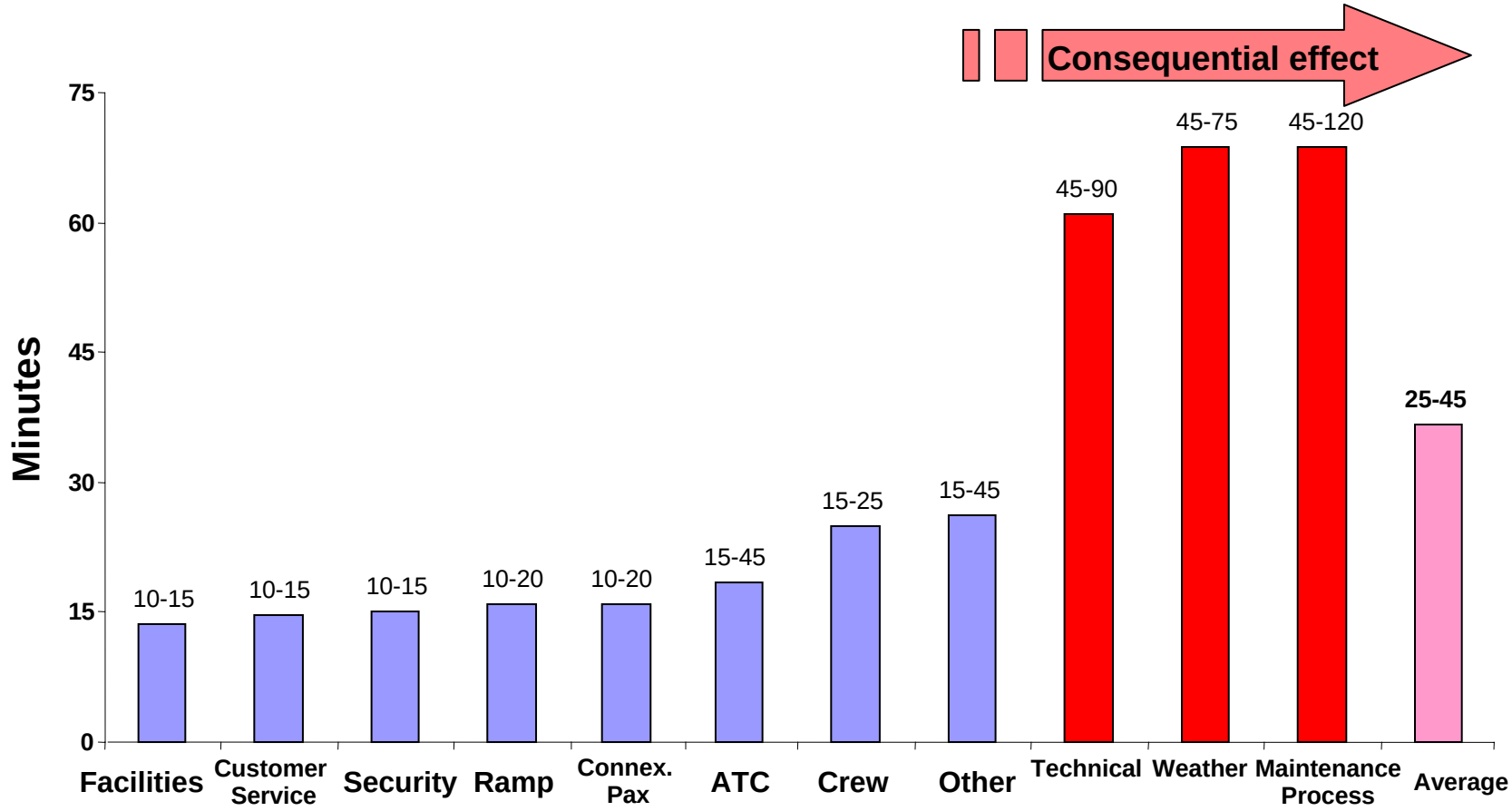


Minutes of Delay
vs. Time

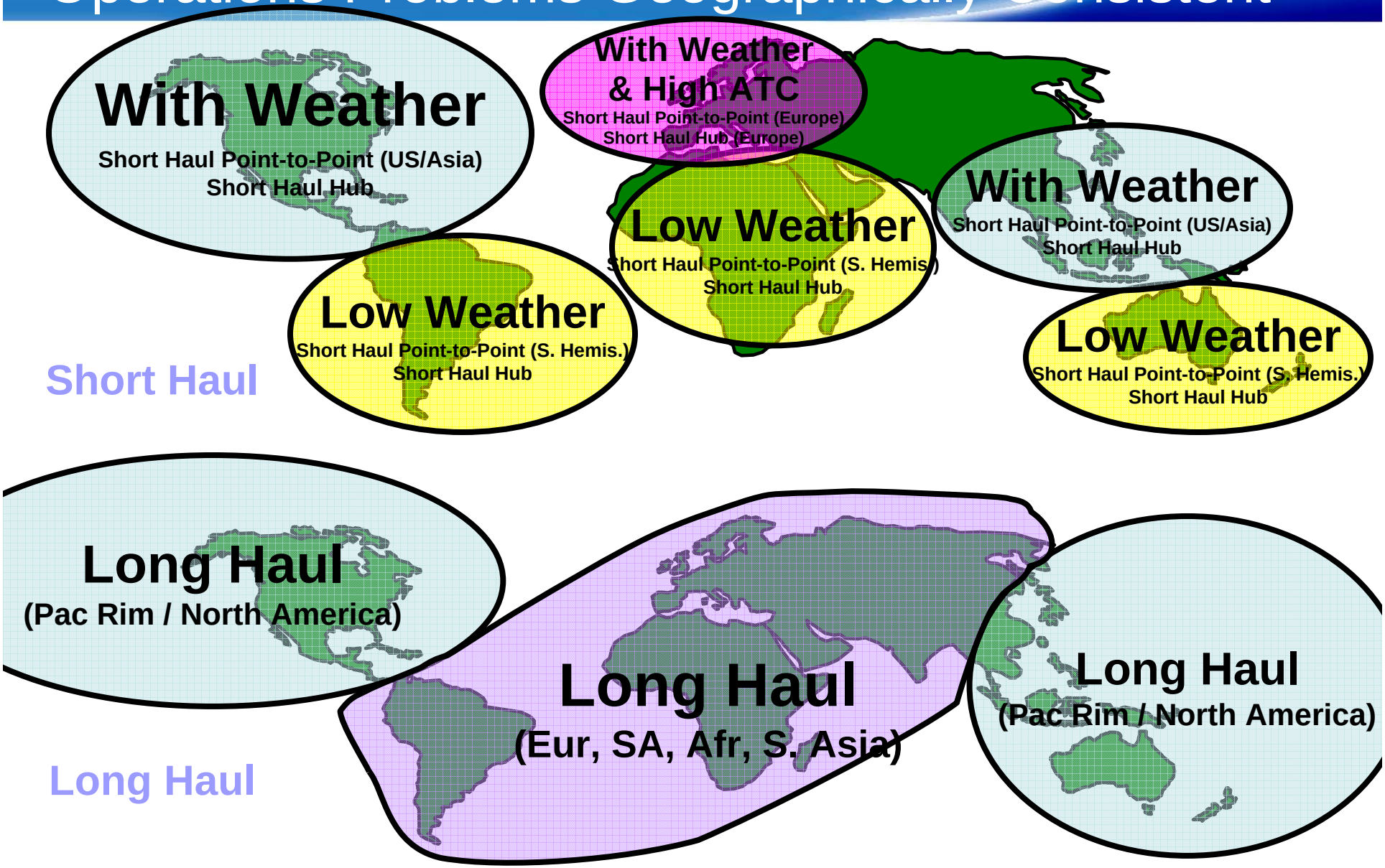
Maintenance Delays Dominate the Length & Cost Picture

Average Delay Length by Category

- **Delay causes have different impacts on the operation**
- **Longer delays magnify their impact through consequential effects**

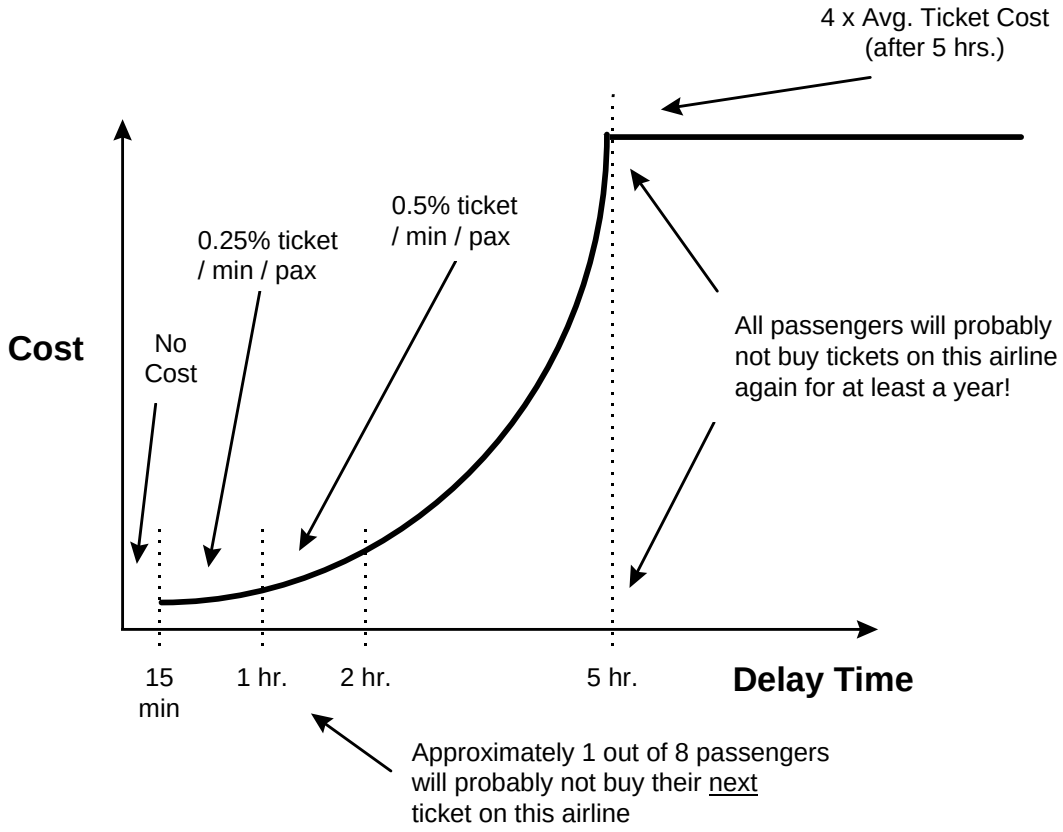


Operations Problems Geographically Consistent



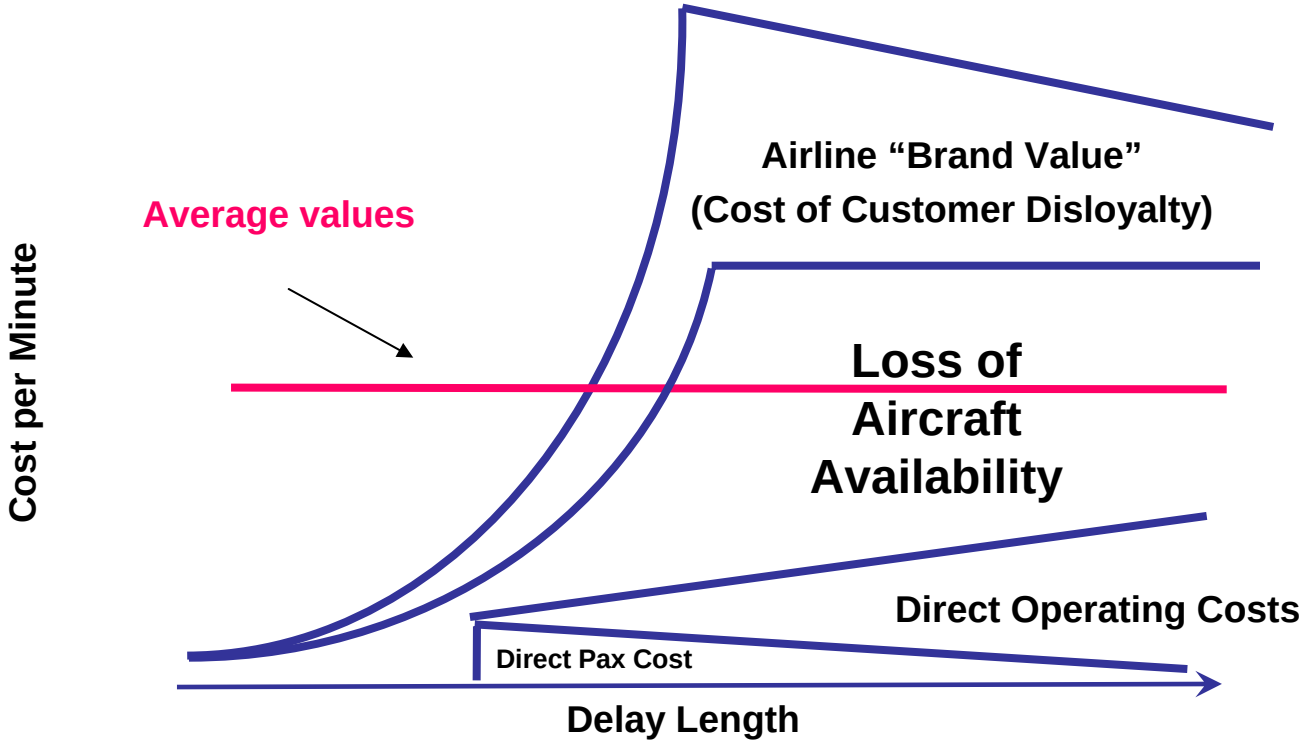
Delay Cost: Passenger Ill-Will Model

- **1988 study at American Airlines – passenger surveys of U.S. narrowbody domestic flights**
- **Produced result $45 per delay minute**
- **Usually applied as an average**



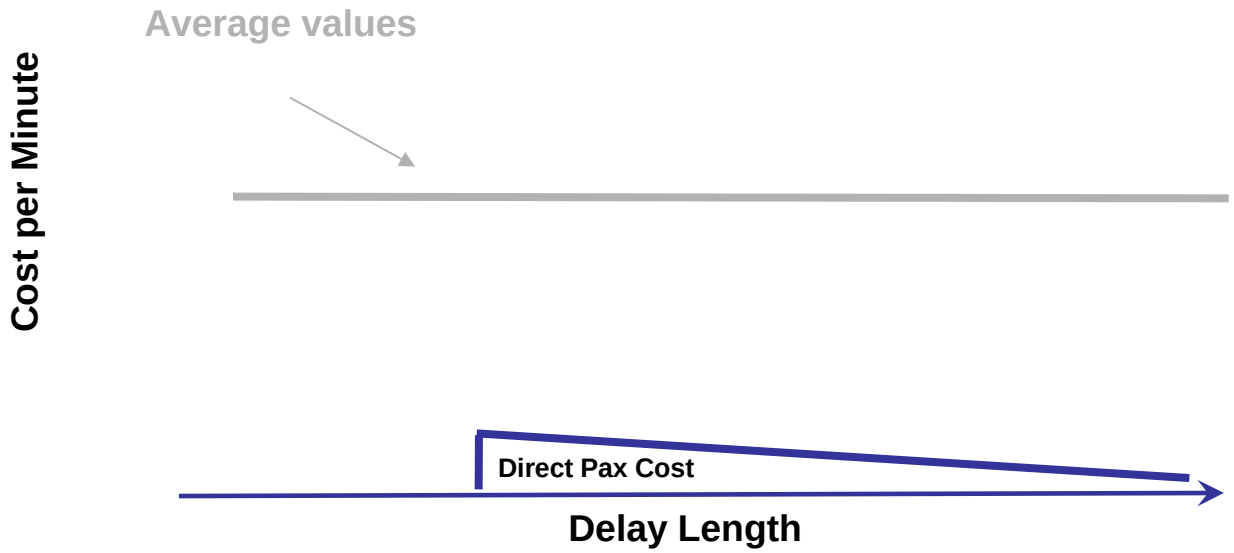
New Delay Cost Curve

- **Getting away from averages – major increase in cost-per-minute as delay length increases**
- **Taking several major cost categories into account**
- **Airline's network & alliances influence cost**



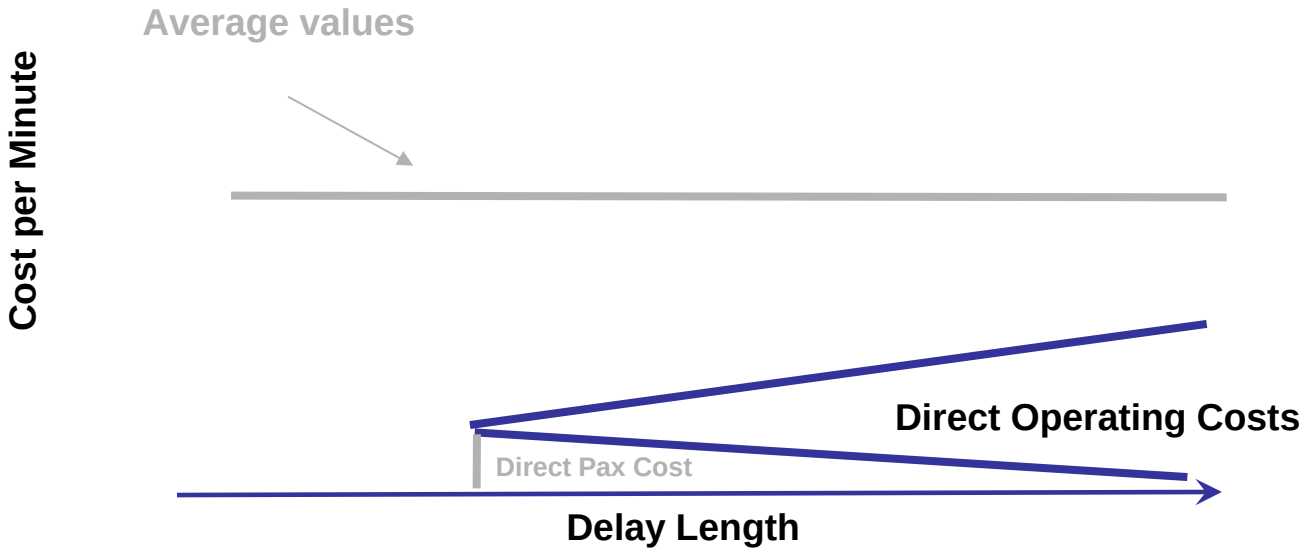
New Delay Cost Curve

- **Passenger costs**
  - **Tracked by most airlines**
    - **Passenger compensation, other direct related costs**
  - **Direct passenger costs non-existent for delays less than 1 – 2 hours**



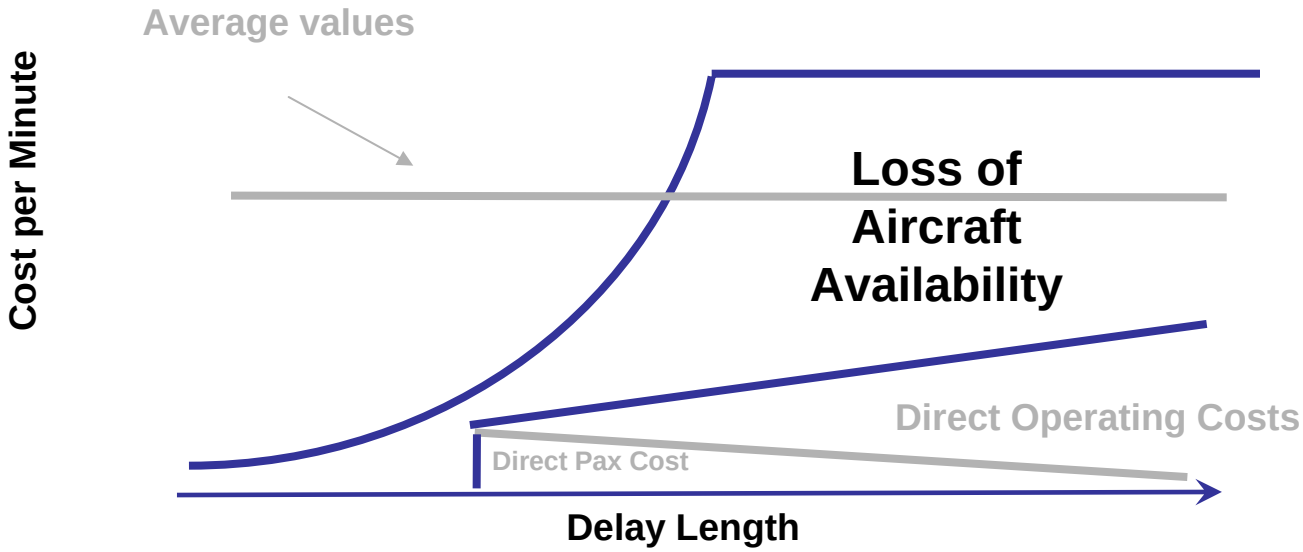
New Delay Cost Curve

- **Operating costs**
  - **Direct operating, maintenance, crew & staffing associated with disruption**
  - **Disruption anticipatory costs**
  - **Costs increase with delay length as long delays mean more consequential delays**



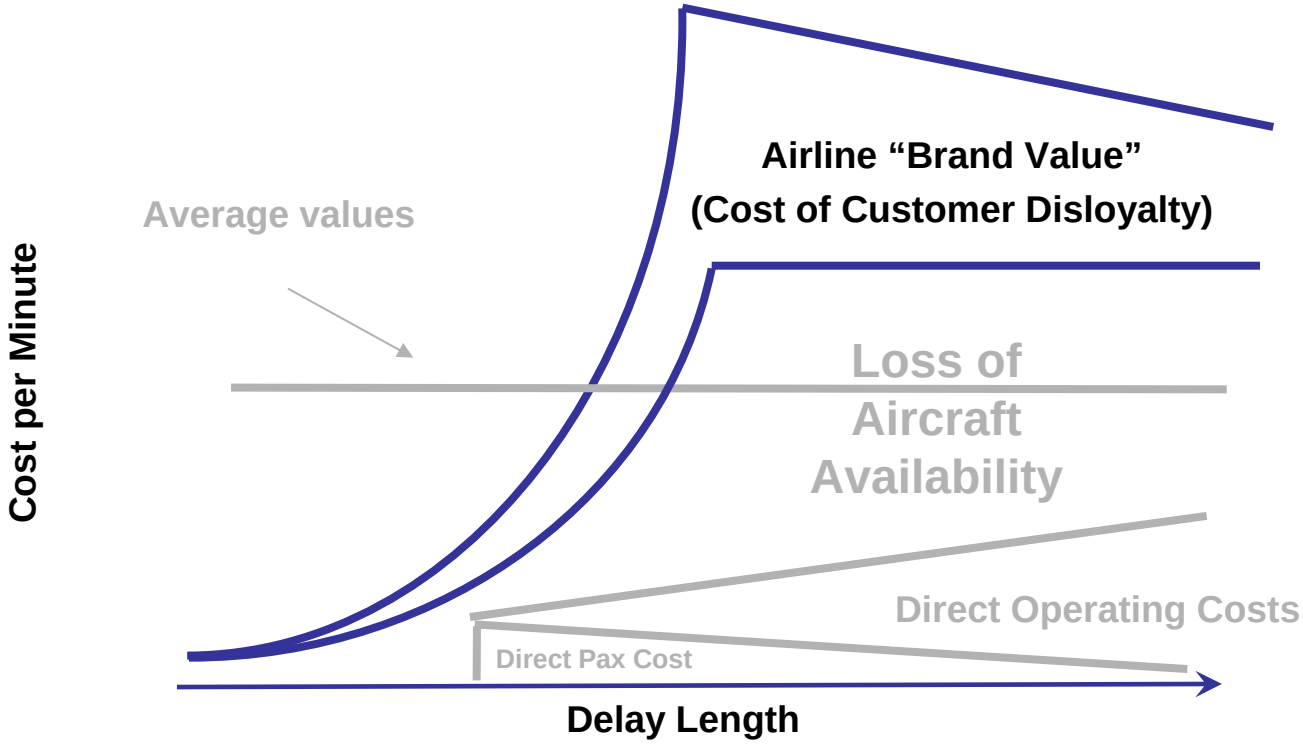
New Delay Cost Curve

- **Aircraft [Un]Availability**
  - **Reduced aircraft utilization, “hidden” operational spare aircraft**
  - **Already scheduled – difference between a “standard” turnaround and “minimum” turn time**



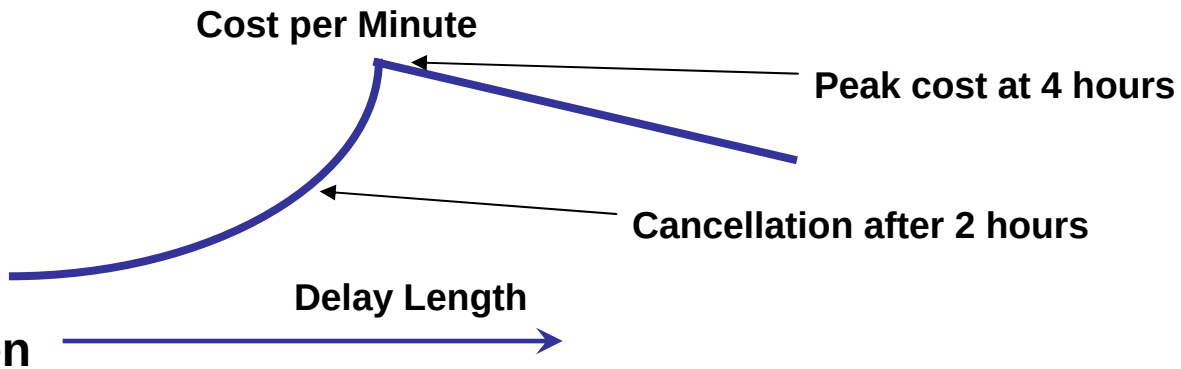
New Delay Cost Curve

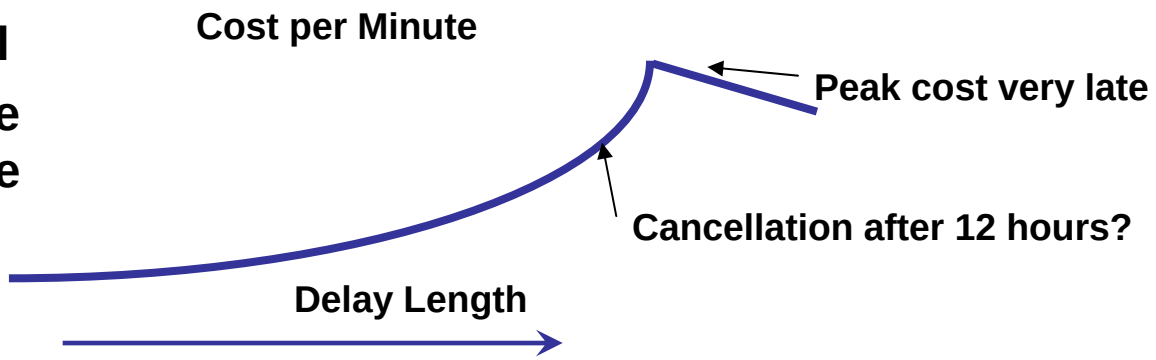
- **Airline "Brand Value"**
  - **A high-brand-value airline has lower costs for very long delays**
  - **Worst case cost is passenger re-accommodation for Premium on a trans-ocean leg**



Airline Network Affects Delay Cost

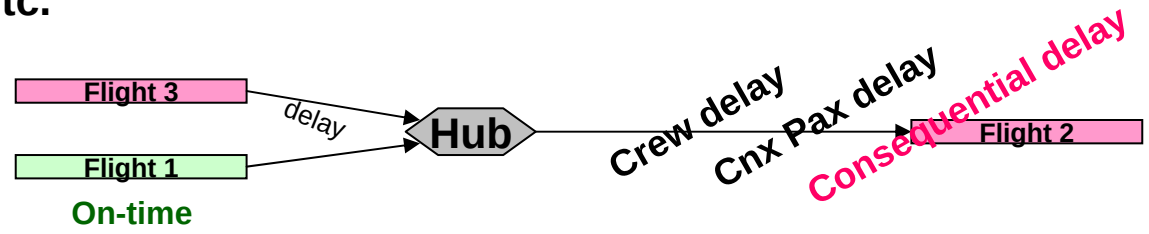
- **Short-haul airline converts delays to cancellations after 2 hours**
  - **Puts passengers on later flights**
  - **Re-integrates airplane back into network when repaired**
- **Long-haul airline delays longer rather than cancel**
  - **Cannot cancel because airplane in wrong place to be re-positioned**



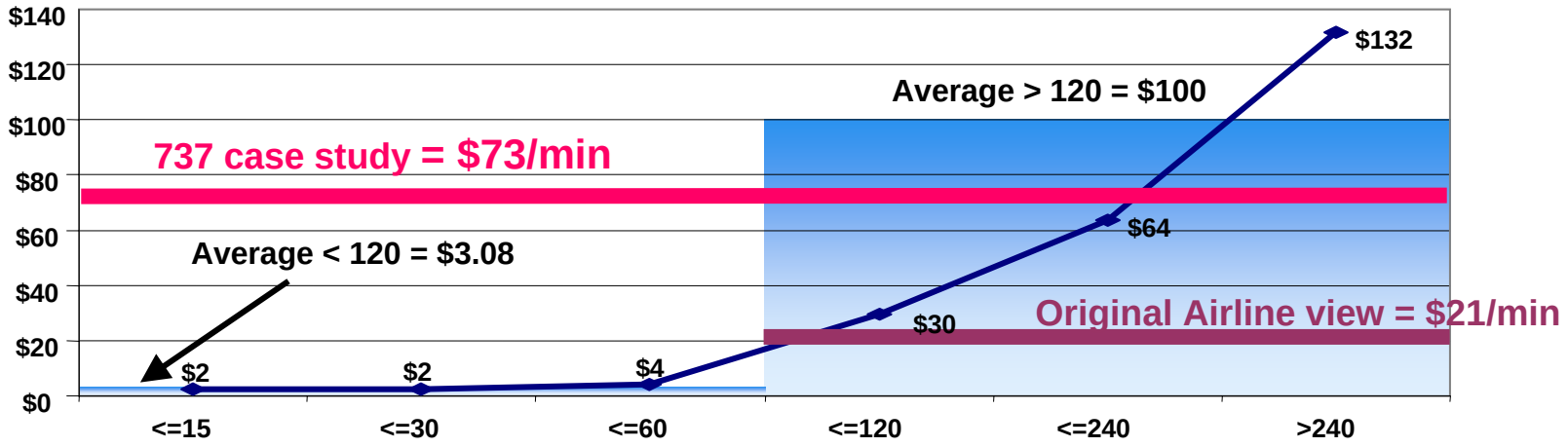


Key Learnings – the Accelerating Cost of Delays

- **Delay Theory: Consequential Delays**
  - **30% to 50% of delays – a function of the network model**
  - **"Follow the airplane" only part of problem – more delays from crews, passengers, etc.**

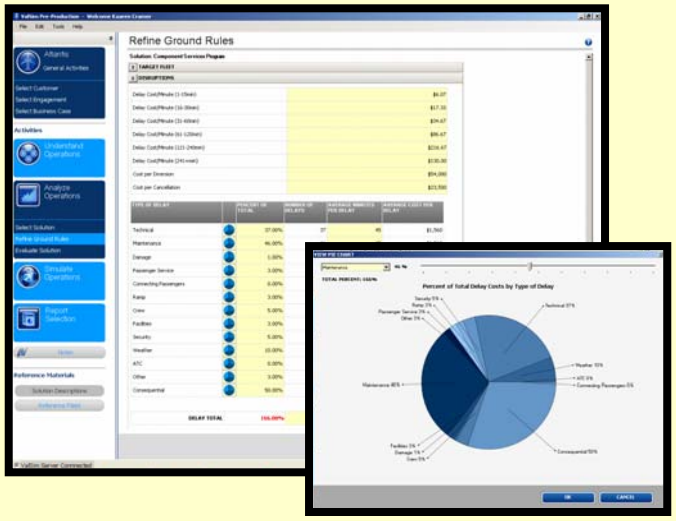


- **Unpredictability of Maintenance delays – greatest total impact**
- **IATA delay codes inadequate for security post-9/11**
  - **"Missing passenger" bag search on flights to U.S. – up to 25% of all delays**
- **Delay Costs: the Accelerating Curve**



Summary: Disruption Methodology in ValSim

- **Analyze Operations**



- **Delay Counts in Minutes**
- **Delay Costs Accelerate**